THE EFFECT OF PROCESSING ON NUTRIENT COMPOSITION OF SELECTED GREEN LEAFY VEGETABLES AND DEVELOPMENT OF VALUE ADDED PRODUCTS

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1. INTRODUCTION

1.1 FOOD SECURITY:

Food is the prime necessity of life. The food we eat is digested and assimilated in the body and used for its maintenance and growth. Hence global food sufficiency and security is not only a worthy goal but one that is essential if the health is to survive in relative pace and prosperity. This thinking gave rise to the concept of food security. 'FOOD SECURITY' means that food is nutritionally adequate in terms of quantity, quality and variety **(Clydesdale, et al., 1998, Radhakrishna, 2005)**. In recent years, most of the research initiatives for food security have focused on four key components of the FAO's definition, i.e. Availability, Accessibility, Acceptability and Adequacy. Attainment of food security ensures achievement of optimum health of an individual **(WHO, 2002)**. Optimum health can be attained only with optimum nutrition **(Malaspina, 1999, B Shrilakshmi, 2003).**

Nutrition is at the threshold of new and revolutionary developments and its potentialities for the improvement of health are vast. Nutrition is that condition which permits the development and maintenance of the highest state of fitness. In order to maintain a healthy life with better nutrition, people need to know the importance of food readily available for their disposal. Though various advances have been made in the field of nutrition, MALNUTRITION is still widely prevalent in many parts of the world and is one of the greatest international problems of the day **(Abrams et al, 2003).**

1.2 MICRONUTRIENT DEFICIENCY:

In the developing country like India serious deficiency disorders particularly micronutrient deficiencies associated with Vitamin A, Iron and Iodine are encountered due to dietary insufficiency. However, despite all the good intentions and the relevant programmes being in place, the nutritional and health status of our vulnerable section is not very encouraging. **Malnutrition is widely prevalent and the "hidden hunger" arising due to malnutrition is no better.** Combating 'hunger' rather than 'hidden hunger' was the major item in the nutrition agenda in earlier years. In recent years, however, micronutrients have acquired the centre stage. The current emphasis on micronutrients may be expected to draw attention to the need to ensure 'nutritive quality' of the diets and not only to their energy and the protein content **(Sommer et al, 2002).**

Micronutrients are life sustaining nutrients that are needed only in small quantities for effective functioning of brain, the immune system, reproduction and energy metabolism but their deficiency make a considerable negative impact on health and learning abilities. The result is devastating public health problem affecting people throughout the socio economic spectrum. Iron, Vitamin A and Iodine deficiencies are among the nutritional deficiencies of greatest public health significance in the world today. Almost one third of children in developing countries are affected to some degree by Vitamin A deficiency, which

impairs their growth, development, vision and immune function, and in extreme cases leads to blindness and death. Iron deficiency, which leads to anemia, is well recognized as the most common dietary deficiency in the world (including developed countries), affecting mostly children and women of reproductive age. It is estimated that more than half of all pregnant women in the world and at least one third of preschoolers suffer from anemia, and many more are iron deficient to some degree. Iron deficiency is harmful at all ages **(Sommer et al, 2002)**.

In young children it impairs physical growth, cognitive development and immunity; at school age it affects school performance; at adulthood it causes fatigue and reduced work capacity; and among pregnant women, anemia may cause fetal growth retardation or low birth weight, and is responsible for a large proportion of maternal deaths **(WHO, 2004)**.

Micronutrient malnutrition is widespread in the industrialized nations, but even more so in the developing regions of the world. At least one third of the world's population is suffering from micronutrient deficiency. Another study reported that iron deficiency is the most widespread micronutrient deficiency in the world, affecting more than 2 billion persons **(WHO, 2001).** Globally, Iron Deficiency Anemia (IDA) affects four to five billion people **(WHO, 2004).** Particularly in developing countries, anemia is most prevalent public health problem and has important health, social and economic consequences. In Bangladesh, the prevalence of anemia among adolescent girls varies from 20% to 40%. Dietary surveys indicate that a large proportion of the adolescent girls do not meet the daily requirements for various micronutrients, including iron, vitamin A, riboflavin and vitamin C. the findings suggest that a substantial proportion of the girls may be suffering from sub clinical deficiencies of micronutrients **(Ahmed et al, 2008).**

According to WHO criteria, a greater than 1% prevalence of night blindness in children aged 24-71 months, indicates a public health problem. It has been suggested recently that a prevalence of night blindness of more than 5% in pregnant women should be added to the list of criteria that signify a public health problem **(WHO, 2004; Sommer et al, 2002).** According to the survey carried out by **NNMB, 2006** in 10 states of India, analysis of blood samples revealed that the overall median vitamin A level was 16.8 mg/dL, and ranged from a low 9mg/dL in Madhya Pradesh to a high 20.1 mg/dL in Tamil Nadu. The levels were similar between age groups and gender. About 62 percent of children in general, had vitamin A levels of <20 mg/dL, indicating sub-clinical VAD, and ranged from a low 49 percent in the state of Tamil Nadu to a high 88 percent in Madhya Pradesh. The proportion of children with sub clinical VAD was significantly higher among 3-5 year children (63.1 percent) compared to 1-3 years (59.6 percent). No significant gender differentials were observed.

Pal et al, 2007, a study was conducted among 4205 pre school age children in Bihta Primary Health Centre Area, Bihar, India. It was found that vitamin A deficiency was significantly higher in children who are vegetarian i.e. nearly 7 percent. Children born to a literate mother had a prevalence of about 1 percent in relation to a corresponding value of nearly 4 percent in children born to illiterate mothers.

1.3 PREVALENCE OF MICRONUTRIENT DEFICIENCY:

Since number of programmes have been launched to combat these micronutrient deficiencies and most successfully being iodization of salt. Iodized salt is now available even in the remote areas and on community shops at affordable prices. Hence here we are going to concentrate on Iron and Vitamin A Deficiencies.

Iron shortage is clinically known as Iron Deficiency Anemia (IDA) and is a serious public health problem. Iron deficiency is one of the most widely prevalent forms of micronutrient malnutrition worldwide **(WHO, 2002).** About 40% of the world's population (i.e. more than 2 billion individuals) is thought to suffer from anemia i.e. low blood hemoglobin. The mean prevalence among specific population groups are estimated to be:

- Pregnant women, infants and children aged 1-2 years, 50%.
- Preschool-aged children, 25%.
- School children, 40%.
- Adolescent, 30-55%.
- Non-pregnant women, 35% **(Hass et al, 2001).**

Another study reported that iron deficiency is the most widespread micronutrient deficiency in the world, affecting more than 2 billion persons. Severe iron deficiency results in anemia, may be the result of other nutrient deficiencies such as vitamin B12 and folate as well as non nutritional causes such as malaria, genetic abnormalities eg Thalassemia **(WHO, 2001).** Globally, Iron Deficiency Anemia (IDA) affects four to five billion people **(WHO, 2004).**

Vitamin A deficiency is widely prevalent, particularly in the developing world. Worldwide, about 3 million pre school aged children present ocular sighs of vitamin A deficiency **(WHO, 2004)**. Recent analysis by WHO indicated that there are approximately 727 million and 4.4 million pre-school children with vitamin A deficiency and xeropthalmia respectively (WHO, 2002). Vitamin A deficiency is, however, more commonly assessed using serum or plasma retinol levels. World Health Organization estimates that 254 million pre school aged children throughout the world have low serum retinol levels and can therefore be considered to be clinically or sub clinically vitamin A deficient **(WHO, 2001).** In the developing world, prevalence rates in this age groups range from 15% up to as high as 60%. The prevalence of night blindness is also high among pregnant women in many poor regions of the world, with rates varying between 8% and 24% **(WHO, 2001).** Night blindness tends to be accompanied by a high prevalence of low concentrations of retinal in breast milk **(Allen et al, 2001).**

According to WHO criteria, **(WHO, 2004)** a greater than 1% prevalence of night blindness in children aged 24-71 months, indicates a public health problem. It has been suggested recently that a prevalence of night blindness of more than 5% in pregnant women should be added to the list of criteria that signify a public health problem **(Sommer et al, 2002).** According to **West et al., 2002,** nearly about 4 million pre-school children were vitamin A deficient.

1.4 CAUSES OF MICRONUTRIENT DEFICIENCY:

The major causes of micronutrient deficiencies are monotonous diet resulting in low nutrient intake and poor bioavailability, especially of minerals and low intake of animal source foods.

The dietary habits of a population group strongly affect the bioavailability of both dietary iron and added fortificant iron **(Layrisse et al, 1996).** Although the efficiency of iron absorption increases substantially as iron stores become depleted, especially where diets are low in meat, fish, fruit and vegetable and diet alone is not enough to prevent iron deficiency in school going children, especially in the developing world **(WHO, 2001).** Lack of iron is usually due to blood loss, poor diet or an inability to absorb enough iron from the diet of an individual **(WHO, 2004).**

The key risk factors for vitamin A deficiency are a diet low in sources of vitamin A (i.e. dairy products, eggs, fruits and vegetables), poor nutritional status, and a higher rate of infections, in particular, measles and diarrhoeal diseases. The best sources of vitamin A are animal source foods, in particular, liver, eggs and dairy products that contain vitamin A in the form of retinal i.e. in a form that can be readily used by the body. It is not surprising then that the risk of vitamin A deficiency is strongly inversely related to intakes of vitamin A from animal sources foods. In fact, it is difficult for children to meet their requirements for vitamin A if their diet is low in animal source foods **(Mosha et al, 2002),** especially if their diet is also low in fat. Fruits and vegetables contain vitamin A in the form of carotenoids, the most important of which is beta-carotene. In a mixed diet, the conversion rate of beta carotene to retinal is approximately 12:1 (higher, i.e. less efficient than previously believed). The conversion of the other pro vitamin A caroteniods to retinal is less efficient, the corresponding conversion rate being of the order of 24:1 **(WHO, 2004).** Various food preparation techniques, such as cooking, grinding and the addition of oil, can improve the absorption of food carotenoids **(Kkreutler et al, 1987).** Some of the causes of vitamin A deficiency are inadequate diet, poverty and ignorance and infections **(Gibson et al, 2000).**

1.5 CONSEQUENCES OF MICRONUTRIENT DEFICIENCY:

The pallor of anemia is associated with weakness and tiredness. It is now recognized that mild to moderate iron deficiency, even without anemia, has adverse functional consequences. It adversely affects the cognitive performance, behavior, and growth of infants,

preschool and school going children; the use of energy sources by muscle and thereby the physical capacity and work performance of adolescent and adults; and the immune status and morbidity from infections in all age groups. Iron deficiency anemia also limits the maintenance of body temperature in individuals exposed to a cool environment. Iron deficiency has been shown to reduce physical endurance, even in the absence of anemia **(Cogswell et al, 2003)** and severe anemia has been associated with an increased risk of both maternal and child mortality **(Van et al, 2001)**. There is substantial evidence to suggest that iron supplementation can reserve the adverse effects of iron deficiency on work capacity and productivity, and on pregnancy outcome and child development **(Hass et al, 2001: Pollitt et al, 2001: Stolzfus et al, 2001)**.

Vitamin A deficiency is the leading cause of preventable severe visual impairment and blindness in children, and significantly increases their risk of severe illness and death. Vitamin A deficiency affects visual functions; indicators of vitamin A status have traditionally relied on changes in the eye, specifically night blindness and xeropthalmia. Other signs include dry skin, broken finger nails and decreased resistance to infection **(USAID, 1999).** An estimated 2,50,000-5,00,000 vitamin A deficient children become blind every year, approximately half of which die within a year of becoming blind. Sub clinical vitamin A deficiency is also associated with an increased risk of child mortality, especially from diarrhea and measles **(Vijayaraghavan et al, 2000).**

1.6 STRATEGIES TO CONTROL MICRONUTRIENT DEFICIENCIES:

Countries need to adopt and support a comprehensive approach that addresses the cause of malnutrition and the often associated 'hidden hunger' which rest intrinsic to in poverty and unsustainable livelihoods, actions that promote an increase in the supply, access, consumption and utilization of an adequate quantity, quality and variety of foods for all population groups should be supported. The aim is for all people to be able to obtain from their diet, all the nutrients; they need to enjoy health and productive life **(Ruel and Levin, 2000)**. There are two basic strategies to meet all the requirements.

Different strategies should be implemented to reduce or control micronutrient deficiencies. They operate in concert with broader strategies to improve the quality of life in particular countries and communities. Actions at all levels- international, local and family to improve household food security, individual health and care can have an impact on micronutrient deficiencies and their control **(Singleton et al, 1999).**

The basic nutrient strategies include:

- Medicinal approach.
- Food-based strategies (Singleton et al, 1999).

1.6.1 MEDICINAL APPROACH:

The provision of micronutrients taken orally or by injection is simply called "supplementation" rather than "medicinal supplementation", but in fact these supplements are generally provided as medicine or used in a medicinal sense **(Solon et al, 1996).** Supplementation with medicinal iron has the advantage of producing rapid improvements in biochemical status. As a strategy it also has a desirable specificity. It can be targeted at the population groups at the greatest risk of becoming micronutrient deficient **(Gomber et al, 2003).**

The institute of medicines has set certain guidelines on the upper limit of iron intake on daily basis. For adult children and infants, the upper limit for adults and teenagers is 45 mg per day regardless of pregnancy and lactation. Infant and child have a maximum recommended dose of 40 mg per day **(www.disabled-world.com)**.

In case of Iron deficiency, infants and pre- school children liquid iron preparations are used. Concentrated drops too can be considered for infants. Chewable and dispersible iron tablets are also available but these add costs without benefits. Iron is available in heme as well as non- heme formulations. While absorption from the heme formulations is about 37% as compared to 5% from non-heme formulations. Although these medicinal supplements have associated side effects of Gastrointestinal tract. **(WHO, 2002).**

Most iron supplementation programmes worldwide use ferrous sulphate, which provides iron in a form that is well absorbed. It is usually given in tablets providing 60 mg of elemental iron, and women are advised to take three tablets per day throughout pregnancy. It is reported that many women do not take the tablets because of perceived adverse reactions. About 200 mg of iron which is in the form of ferrous sulphate is given for the age of 5 to 10 year children on daily or weekly basis for 2 months **(Gibson et al, 2000)**.

In a double blind study for gastro intestinal side effects, comparison was done on different ferrous salts, like sulphate, gluconnate and fumarate with a placebo. All the preparations had identical appearance. Two doses of elemental iron were compared separately, 222 mg per day and 105 mg per day. When 222 mg per day was given, the incidence of gastro intestinal side effects was 13% in the placebo and 25% in the iron groups **(Pollitt, 2001).** When 105 mg per day of iron was compared with placebo no difference in the gastro intestinal side effects were found. Thus in lower doses, which are most likely to be used in community programs, there are no differences in the gastrointestinal side effects **(WHO, 2001)**.

Vitamin A is a fat soluble vitamin; once absorbed, it is excreted slowly and a good proportion of a high dose remains for some time in the body. Therefore large doses of vitamin A can be given at long intervals.

Target group	Vitamin A dose

All mothers irrespective of their mode of infant feeding up to six weeks postpartum if they have not received vitamin A supplementation after delivery	200 000 IU
Infants aged 9–11 months Children aged 12 months and older	100 000 IU 200 000 IU
Children aged 1–4 years	200 0 IU

The optimal interval between doses is four to six months. A dose should not be given too soon after a previous dose of vitamin A supplement: the minimum recommended interval between doses for the prevention of vitamin A deficiency is one month (the interval can be reduced in order to treat clinical vitamin A deficiency and measles cases). Government is using medicinal vitamin A supplementation through universal supplementation programme to reach all children of a defined age group in our country **(Gibson et al, 2000)**.

The **Beaton Report, 2005** concluded that all-cause mortality among children aged 6-59 months was reduced by 23 percent through vitamin A supplementation in areas where vitamin A deficiency was a public health problem. However, comprehensive control of vitamin A deficiency must include dietary improvement and food fortification in the long term.

The medicinal approach for combating micronutrient deficiencies especially of Iron and Vitamin A is less popular because of lower acceptability of medicines by subjects because of the related side effects gastrointestinal tract like diarrhea, nausea etc. Number of studies have also reported that accidental over dose of iron containing medicinal supplements may cause fatal poisoning in children younger than 6 years. Symptoms of overdose of vitamin A may include severe headache, tiredness, dizziness, mental/mood changes such as irritability, depression, loss of appetite, dark urine, severe stomach/abdominal pain.

In all supplementation programmes there is a need to establish a record to reduce the possibility that subjects will get high dose supplements too frequently and therefore risk toxicity. Micronutrient supplementation programmes should be used in combination with activities to improve dietary intake of foods rich in vitamin A and iron with public health measures aimed to reduce these deficiencies. Therefore various organizations are now laying stress on "**FOOD BASED STRATEGIES (Elizabeth et at, 2008).**

1.6.2 FOOD BASED STRATEGIES:

Food based strategies are working as a tool to prevent micronutrient deficiencies. These are defined as 'a preventive and comprehensive strategy that uses food as a tool to overcome micronutrients deficiencies and ensures a supply of small quantities of micronutrients on a continuous ongoing basis with an aim to provide micronutrients through natural dietary sources. Dietary diversification, horticulture, food fortification and nutrition and health education are all included in the food based strategy. The objective of the food based strategy is to ensure that people get micronutrients in sufficient quantity through their daily diet. A number of researches have been done in this direction and has given positive results **(Park and Park, 2000; Misra et al, 2001; Gopalan et al, 2001; WHO, 2001; Reddy et al, 2002; Adfule et al, 2002; NIN, 2003; Bamji et al, 2003; ICMR, 2003; Sri Lakshmi, 2003)**.

(i) Nutrient Education: Nutrition education is the process by which people gain knowledge of nutrition and are persuaded to bring about required changes in their food habits.
(ii) Dietary Diversification: It involves diversification of the diet to increase the consumption of iron, vitamin A and other micronutrients on a daily or continuing basis to prevent micronutrient deficiencies.
(iii) Food Fortification: Food fortification refers to the addition of micronutrients to processed foods. In many situations, this strategy can lead to relatively rapid improvements in the micronutrient status of a population, and at a very reasonable cost. Food fortification reinforces and supports ongoing nutrition improvement programmes and should be regarded as part of a broader, integrated approach to prevent micronutrient deficiency malnutrition, thereby complementing other approaches to improve micronutrient status **(WHO, 2001)**.

A study was done by **Singh et al, 2005** in the development and nutritional evaluation of products prepared from dried powder of cauliflower leaves and it was highlighted that the dehydrated cauliflower leaves can be used for development of various recipes. These products if incorporated in the diet can help to reduce the incidence of iron and vitamin A deficiency. Community trials have shown that preschool child mortality can be reduced by 25-30 percent in malnourished population when children over five months of age are supplemented with vitamin A directly or vitamin A fortified food. This supplementation leads to approximately 2.5 million preventable child deaths occurring each year to underlying vitamin A deficiency.

Cauliflower greens are good source of iron which contains about 40 mg of iron per 100 gram of leaves. Therefore considering the iron content of cauliflower greens, which has not been widely used as food, it has been attempted to try its efficiency in improving blood hemoglobin levels. Twenty girls residing in the hostel of PSG college of Arts and Science,

Coimbatore, in the age range of 20 to 22 years were selected for the study. The selected subjects were grouped for the feeding trial. The subjects were divided into two groups. In the feeding trial, the standardized recipe of cauliflower leaves porial providing 15 mg of iron was given to the girls daily for 100 days to these adolescent girls whose hemoglobin levels were below 12g percent. The blood hemoglobin levels were measured in both groups at an identical time period after 100 days of feeding trial. The effect of feeding was determined after 100 days. The mean hemoglobin levels before the feeding trial in both the control and experimental groups were found to be 10.32 g/dl and 10.6 g/dl respectively. The mean hemoglobin levels after the feeding trial in the respective groups were found to be 10.3 g/dl and 13.56 g/dl respectively **(Bhavani et al, 2004).**

Hence we can conclude that **a food-based rather than drug-based approach will be the proper answer to the problem of micronutrient deficiency.** A number of studies have been conducted to highlight beneficial effect of value addition through locally available micronutrient rich food and one such product is Green Leafy Vegetables.

1.7 VALUE ADDITION:

GREEN LEAFY VEGETABLES play an important role in the diet as they provide essential micronutrients and minerals. India is fortunately blessed with a wide variety of inexpensive foods rich in provitamin A carotenoids. Though India is world's second largest producer of vegetables, hardly two percent of produce is processed and utilized. Thirty to forty percent of the annual produce is wasted due to lack of preservation infrastructure. Although there are number of techniques by which we can improve the nutritive quality and shelf life of green leafy vegetables and ensure their consumption on daily basis **(Adulfe et al, 2002)**.

1.7.1 BLANCHING:

Blanching is one of the method for preserving the nutrients losses in food products especially of Green Leafy Vegetables Blanching is a unit operation prior to freezing, canning or drying in which fruits or vegetables are heated for the purpose of inactivating enzymes, modifying texture, preserving color, flavor, and nutritional value, and removing trapped air- microwave vegetables and fruits blanching were retained ascorbic acid and carotene, and very short processing time compared to conventional water or steam blanching **(www.wikepedia.com)**.

The effect of blanching on the anti nutritional content was studied in cabbage, turnip, collard, sweet potato and peanut leaves. All the vegetables contained various amounts of phytic acid, tannic acid and/or oxalic acid. Phytic acid content ranged from 0.31 mg/100g in sweet potato to 3.97 mg/100g in collard. Oxalic acid was in trace amounts in cabbage and turnip; but high concentrations were found in sweet potato (469.67 mg/100 g) and peanut greens (407.00 mg/100 g). Levels of phytic acid was significantly reduced by conventional and microwave

blanching methods. In general, blanching is recommended as an effective method for reducing the anti nutritional factors in green vegetables. Blanching also helps to destroy microorganisms on the surface of the vegetables **(Mosha et al, 1995).**

1.7.2 DEHYDRATION:

Oven drying: The leaves were loaded on the trays forming one single layer of the dehydrator and were dried in the dehydrator by forced air technique. The oven was preheated to 60°C and then the loaded tray was added each time, until all the leaves were done. The temperature was maintained at 60°C and the leaves were left for 1 h for their drying. Vegetables were sufficiently dried till they became crisp and brittle to touch **(Joshi and Mehta, 2010)**.

The selected green leafy vegetables namely Alaikeerai, Coriender Leaves, Curry Leaves, Drumstick Leaves, Mint and Mulla Keerai were subjected to dehydration using different methods. They include sun, oven, microwave, vacumm, freeze and solar drying. Since dehydrated vegetables are concentrated source of carotenes, addition of small amount of these foods in various dietary preparations could be of immense value in meeting the daily vitamin A requirements. Carotene analysis was carried out for the entire raw and dehydrated sample. Results reveled that in the different dehydrated forms of green leafy vegetables up to 90% carotene retention was obtained in freeze drying and microwave and hence these methods could be considered as the best methods of dehydration for retention of carotenes **(Kowsala et al, 2001).**

Studies have reported the significance of drumstick leaves as a source of vitamin A. These leaves could retain 50 percent of their beta carotene on shade dehydration and the dehydrated leaves could be easily incorporated into traditional Western Indian recipes without altering their acceptability characteristics **(Nambiar et al, 2003)**.

The dehydrated green leafy vegetables are concentrated sources of micronutrients and their antioxidant activity has enhanced potential interest for improving the efficacy of different green leafy vegetables. The consumption of these vegetables especially underutilized green leafy vegetable play a role in preventing human diseases **(Sheetal et al, 2007)**.

A study was conducted by **Lakshmi et al, 2007** on the development and evaluation of vegetables based antioxidant mixes. Consumption of antioxidants helps to provide the body with increasing capacity to neutralize harmful free radicals. The content of antioxidant in vegetables may contribute to the protection from diseases. Antioxidants from vegetable sources are more economical and a steady supply of antioxidants could be ensured daily. Five commonly used vegetables comprising of four green leafy vegetables namely agathi, coriander leaves, curry leaves, drumstick leaves and one root vegetable carrot were selected for the study. All the vegetables were dried by sun, shade and cabinet drying methods to get vegetable

powders. They were analyzed by standardized techniques (AOAC, 2005). Dehydration of the five selected vegetables showed that shade drying was found to be the best compared to the other two types of drying regard to nutrient retention. Shade dried powder had better nutrient retention.

1.8 PRODUCT FORMULATION AND ORGANOLEPTIC EVALUATION:

New product development is the term used to describe the complete process of bringing a new product or service to new market. There are two parallel parts involved in the new development product process, one involves the ideas generation, product design and detailed engineering; the other involves market research and market analysis. The knowledge of methods of food preservation is applied for the beginning of new dimensions in food technology. In fact the regional variation in food dishes and availability of wide range of fruit and vegetables has added to innovation or new product development which has numerous for exploration. Product development is critical for boosting food industries in country like India which is the second largest producer of fruit and vegetables. The new products developed have to be evaluated with simple and scientific methods, for ex sensory evaluation techniques, which one applied to new concept of recipes and less popular regional fruit and vegetable products can proved to be revolutionary **(www.wekipedia.com)**.

When the quality of a food product is assessed by means of human sensory organs, the evaluation is said to be sensory or subjective or organoleptic. Every time food is eaten a judgment is made. Sensory quality is a combination of different senses of perception coming into play in choosing and eating a food. Appearance, flavor and mouth feel decide the acceptance of the food. The effective characteristic is not the property of the food, but the subject's reaction to the sensory qualities of food. This reaction is highly conditioned by a variety of psychological and social factors and in the final analysis, plays a vital role in the acceptance and preference of foods **(B Sri Lakshmi, 2003)**.

Green leafy vegetables are rich in micronutrients and could be used to prepare nutritious mixes to enhance their nutrient content. Amaranth leaves, which are less expensive and are available throughout the year. The drying of amaranth leaves included sorting, washing, blanching for two minutes in boiling water and sun drying. Dried and processed amaranth leaf powder was incorporated at a level of 2.5 to 10 percent and termed as amaranthus incorporated nutritious mix (noodles, vermicelli and pasta). The findings of the study revealed that the developed products with amaranth leaf powder incorporations were highly acceptable from the organoleptic evaluation of commonly consumed recipes. The nutrient content and the quality characteristics were highly satisfactory. Thus the present investigations proved the feasibility of developing nutritious mix incorporating low cost micronutrient rich foods like green leafy vegetables and developed commonly consumed products from them **(Kowsalya et al., 2010).**

A spice mixture containing 10% curry leaf powder was incorporated in chapati, seasoned potatoes and cooked rice and acceptability of the products was evaluated. Curry leaf powder incorporated products had higher levels of beta carotene, iron, calcium and dietary fiber in comparison to control. Respondents expressed willingness to use curry leaf powder incorporated products in diet for reasons of health **(Shenoy et al, 2000).** Cauliflower leaf powder incorporated at 10% level in masala biscuits, masala buns, gingelly chikki, wheat soy halwa and nippattun had mean acceptability scores of 3, 4, 3.6, 3.4 and 3.9 respectively on a 5 point hedonic scale. Products were found to be rich in iron, beta carotene and calcium and were highly acceptable **(Begum et al, 2000).**

A study was done on acceptability studies of products prepared with colocasia leaves by **Vasundhara et al, 2009**. This study explores the possibility of utilizing fresh colocasia leaves in common dishes to increase the intake of greens as a source of micronutrients. Ten food products were developed and standardized out of which six were greens, dhal and vegetable combinations and four were snack items. Nutrient content of the prepared recipes especially of dietary fiber, beta carotene, calcium and iron were higher than the control. An overall increase up to 50percent in the nutrient content of the prepared food products with colocasia than that of control recipes were observed.

1.9 EFFECT OF PROCESSING TECHNIQUES ON NUTRIENT RETENTION AND SHELF LIFE OF PRODUCTS:

Nutritional importance of vegetables cannot be neglected our daily meals. Some of the vegetables are used in raw form as salad, but most of them require cooking for the improvement of digestibility and palatability. Many raw vegetables contain high levels of vitamins and minerals, but cooking can remove much of this nutritionally important content. Some of the vitamin loss that occur during cooking is caused by oxidation, degradation and vaporization. Method of cooking, temperature and duration may also effect significantly on the nutritive values of vegetables. Excessive cooking may also cause an adverse affect on the digestibility of the vegetables. In cooking, there is 5 to 30 percent loss of nutrients especially of beta carotene and vitamin C. Baking can result in the loss of nutrients and it only depends upon the duration and temperature **(www.disabled-world.vcom)**.

Many raw vegetables contain high levels of vitamins and minerals, but cooking can remove much of this nutritionally important content. Some of the vitamin loss that occur during cooking is caused by oxidation, degradation and vaporization. A experiment was conducted to assess the loss of beta carotene in vegetables (spinach, coriander and bathua leaves). Pen frying, boiling, braising and stewing were the cooking methods used in the experiment. Results showed that no significant loss of beta carotene was measured **(Renquist et al, 1978).Surywanshi et al., 1989** studied effect of frying on polyphenols in ground nut kernels. Frying was carried out in ground nut oil at 147° C for 2 min. Results showed significant decrease

in polyphenol content. Soaking prior to frying resulted in more reduction of polyphenols than roasting.

Cooking often destroys considerable quantities of vitamins and minerals and denatures some constituents in food. The influence of heat during cooking may destroy the nutrient profile of the foodstuffs. Solar cooking was found to be superior to conventional method of cooking in terms of conversation of most nutrients. Data showed that there was not much difference between the retention of the major nutrients like energy and protein by both of the methods of cooking, but the retention of micronutrients in green leafy vegetables (amaranth, drumstick and cabbage leaves) were better in solar cooking. Increased percentage retention of beta carotene (10 to 20%) was noticed in drumstick and a similar retention was observed in amaranth (16.4%) and cabbage (23%). Because of slow penetration of heat and lower temperature involved, solar cooking retained higher amounts of the significant nutrients thus showing an edge over the conventional methods **(Usha et al., 2009)**.

A study was done on the effect of heat on the antioxidant status of selected green leafy vegetables by **Padma et al, 2005**. The leaves (drumstick leaves, manathakkali leaves and chekkurumeni leaves) were subjected to boiling in distilled water, cooled and drained off the excess water. Boiling resulted in a drastic loss of catalase and peroxidase activity in all the three leaves. The three selected leaves contain potential antioxidants, which can render protection against oxidant induced tissue damage. A considerable proportion of these compounds are destroyed during boiling, but some components exhibit thermostability, which may be important in rendering protection.

1.10 EFFECT OF PROCESSING ON SHELF LIFE OF PRODUCTS:

The shelf life of the product is evaluated by identifying the quality attributes such as color, flavor and texture as well as microbial analysis. A study was done by Perchonok et al on Thermo stabilized shelf life study on prepared vegetable i.e. Palak Paneer. The overall acceptability and specifically aroma scores decreased over time likely due to oxidation of the spices and lipids. A color change indicates a loss of green color in the spinach and a darkening of the cheese over time. Shelf life of the product projected to be 39 months at 72°F.

Hence, it should be ensured that the consumption of vegetables especially Green leafy vegetables should be done on daily basis for their rich nutrient composition and for their various health benefits.

1.11 SIGNIFICANCE OF THE STUDY:

WHO, 2009 was estimated that the iron deficiency anemia is the number one nutritional disorder in the world with as much as 80 percent of the world's population. Globally, night blindness affects 5.2 million pre school age children and 9.8 million pregnant women, which corresponds to 0.9 per cent and 7.8 per cent of the population at risk of VAD (Vitamin A

Deficiency), respectively. Green leafy vegetables are a store house of many micronutrients and they occupy an important place in the diets of millions of people in India. Green leafy vegetables are rich source of vitamin A, iron and other micronutrients, they are even cheap in cost but because of lack of nutrition education people are unaware of their rich composition. In a country like India where most of the people are engulfed in poverty and can't afford the expensive food products and suffer from various deficiency diseases there is an immediate **need to identify cheap and easily available source rich in iron, vitamin A and other micronutrients** and green leafy vegetable can be one of them.

In nature, there are many underutilized greens of promising nutritive value, which can nourish the ever increasing human population. Now a days, underutilized foods are gaining importance as a means to increase the per capita availability of foods. Therefore, an attempt was made to identify and analyze the various underutilized green leafy vegetables for their nutrient content. Green leafy vegetables contain high amount of moisture and are not good source of calories and are highly perishable. Vegetables can be therefore processed and preserved by simple traditional methods like blanching and dehydration.

BLANCHING stops all life processes, inactivates enzymes, fixes green color and removes certain harsh flavors common in green leafy vegetables. DEHYDRATION is one of the simplest method of preservation the green leafy vegetables. In dehydration, the moisture content of the food is reduced and the growth of microorganisms in the dried food is retarded. Dehydrated green leafy vegetables are equal to legumes in their nutrient content. Dehydration also makes them a concentrated source of vitamins and minerals and thus they become a very suitable "NATURAL FORTIFICANT". In addition to increasing variety in the menu and reducing wastage, dehydrated vegetables are simple to use and have a longer shelf life than fresh vegetables. The dried leaf powder can then be incorporated in various recipes in acceptable proportion. In this way we can ensure the consumption of micronutrient rich green leafy vegetables on daily basis. Keeping in view, the importance of green leafy vegetables, the present study has been planned to develop various recipes by incorporating vitamin A and iron rich, lesser used greens of cauliflower and carrot leafy vegetables with the following objectives.

1.12 OBJECTIVES OF THE STUDY:

- To perform nutritional estimation of selected fresh green leaves.
- To perform nutritional estimation of Blanched dehydrated and Non Blanched dehydrated green leafy vegetables.
- To formulate recipes by incorporating different proportions of dry leafy powder and perform their organoleptic evaluation.

- To assess and compare the effect of various cooking methods on nutrient composition of both control and most accepted recipes.
- To study the shelf life of most accepted recipes
- To calculate cost and nutritive value of most accepted products.

2 METHODOLOGY

This chapter of study is mainly concerned with the methodological aspects pertaining to the present investigation. The design of the study refers to the logical manner in which units of study will be assessed and analyzed for the purpose of the drawing conclusions. The study will be accomplished in the following ten phases:

PHASE I- Procurement and preparation of green leafy vegetables (storing and washing).

PHASE II – Analysis of nutrient composition of fresh leaves (cauliflower and carrot).

- Nutrition estimation: Iron (mg/100g), calcium (mg/100g), beta carotene (µg/100g) and vitamin C (mg/100g).
- Non nutritional compounds: Total phenols (percent), Moisture (percent) and ash (percent).
- Anti nutritional compounds: Fiber (g/100g), oxalates (mg/100g) and phytates (g/100g).

PHASE III- The leaves will be divided into two lots:

- Blanched dehydrated.
- Non blanched dehydrated.

PHASE IV- Analysis of nutritional composition of both the lots (blanched dehydrated and non blanched dehydrated).

- Nutrition estimation: Iron (mg/100g), Calcium (mg/100g), β carotene (µg/100g) and Vitamin C (mg/100g).
- Non nutritional compounds: Total phenols (percent), Moisture (percent) and Ash (percent).
- Anti nutritional compounds: Fiber (g/100g), Oxalates (mg/100g) and Phytates (g/100g).

PHASE V- Product formulation:

- Roasting (ladoo, sattu, panjiri and khakhara).

PHASE VI- Organoleptic evaluation of recipes by using 5 point hedonic scale.

PHASE VII- Effect of cooking method on nutrient composition of control and most accepted recipe.

- Nutrition estimation: Iron (mg/100g), beta carotene (µg/100g)

PHASE VIII- Shelf life of the most accepted product by microbial analysis.

PHASE IX- will be divided into two parts

- Cost analysis of accepted product
- Nutritive value of accepted product
- Statistical analysis

PHASE X- Report writing:

Material and methods:

PHASE I – Procurement and preparation of green leafy vegetables by storing and washing(cauliflower and carrot).

Carrot and cauliflower greens will be used for present study because of their good nutritive value and availability. These leaves will be procured from Horticulture Centre of Durgapura. The variety of the leaves will be identified. The botanical and taxonomical details will be gathered.

PHASE II - Analysis of nutrient composition of fresh leaves (cauliflower and carrot).

CATEGORIES	PROCEDURE	PRINCIPLE
1. NUTRITIONAL ESTIMATION		
• IRON	WONG'S METHOD	Iron is determined colorimetrically making use of the fact that ferric iron gives a blood red color with potassium thiocynate.
• β-CAROTENE	HPLC	HPLC separates mixture of compounds on the basis of polarity. It is used to analyze, identify, purify and quantify compounds
• VITAMIN C	TITRIMETRIC METHOD	The blue color produced by the reduction of 2,6-dichlorophenol indophenols by ascorbic acid is estimated colorimetrically.
• CALCIUM	TITRIMETRIC METHOD	Calcium is precipitated as oxalate and is titrated with standard potassium

		permagnate
2. NON NUTRITIONAL ESTIMATIONS		
• TOTAL PHENOL	UV SPECTROPHOTOMETRIC METHOD	UV Spectrophotometer has four main components i.e. UV light source, the sample, detector and recorder. The intensity of detected light will be lesser than the original UV light. The 'absorbed light' corresponds to the concentration of the target component in the sample.
• MOISTURE	AIR OVEN DRYING METHOD	This is based on the principle of drying the sample to constant weight in an air oven.
• ASH	MUFFLE FURNACE	Organic matter is burnt off at as low temperature as possible and the inorganic material is cooled and weighed.
3. ANTI-NUTRITIONAL ESTIMATION		
• FIBER	CERAMIC FIBER FILTER METHOD	Crude fiber is loss on ignition of dried residue remaining after digestion of sample with 1.25% (w/v) H2SO4 and 1.25% (w/v) NaOH solutions under specific conditions.
• OXALATES	TITRIMETRIC METHOD	The oxalic acid is extracted in HCl and precipitated as calcium oxalate by adding calcium chloride which is then washed and titrated with N/20 KMNO4 in the presence of dilute sulphuric acid at 70°C. one ml of N/20 KMNO4 is equivalent to 0.00225 g of oxalate
• PHYTATES	SPECTROPHOTOMETRIC METHOD	The phytic acid is extracted in 0.5 M nitric acid and treated with ferric ammonium sulphate and isoamyl alcohol. Pink color is dissolved in alcohol layer with ammonium thiocynate, which is invariably proportional to phytic acid content

PHASE III - From the entire lot of each leaf, half of the leaves will be blanched and then dehydrated while half will be directly dehydrated just to compare the effect of blanching on nutrient retention. Blanching is done by boiling vegetables (88°C) briefly for 5-6 minutes, chilling them in ice water at 2°C for 2 to 3 minutes, then reheating them slowly, blanching preserves texture, color and flavor. After blanching the leaves, they will be prepare for drying.

The technique of drying is probably the oldest method of food preservation practiced by mankind. The removal of moisture prevents of growth and reproduction of microorganisms causing decay and minimizes many of the moisture mediated deterioration reactions. The technique which is used in the present study is **Microwave drying** method.

PHASE IV- Analysis of nutrient composition of both the lots:

Nutritional composition of green leafy vegetables will be analysed using standard techniques.

CATEGORIES	PROCEDURE	PRINCIPLE
1. NUTRITIONAL ESTIMATION		
• IRON	WONG'S METHOD	Iron is determined colorimetrically making use of the fact that ferric iron gives a blood red color with potassium thiocynate.
• β-CAROTENE	HPLC	HPLC separates mixture of compounds on the basis of polarity. It is used to analyze, identify, purify and quantify compounds
• VITAMIN C	TITRIMETRIC METHOD	The blue color produced by the reduction of 2,6-dichlorophenol indophenols by ascorbic acid is estimated colorimetrically.
• CALCIUM	TITRIMETRIC METHOD	Calcium is precipitated as oxalate and is titrated with standard potassium permagnate
2. NON NUTRITIONAL ESTIMATIONS		
• TOTAL PHENOL	UV SPECTROPHOTOMETRIC METHOD	UV Spectrophotometer has four main components i.e. UV light source, the sample, detector and recorder. The intensity of detected light will be lesser than the original UV light. The 'absorbed light' corresponds to the concentration of the target component in the sample.
• MOISTURE	AIR OVEN DRYING METHOD	This is based on the principle of drying the sample to constant weight in an air oven.
• ASH	MUFFLE FURNACE	Organic matter is burnt off at as low temperature as possible and the inorganic material is cooled and weighed.
4. ANTI-NUTRITIONAL ESTIMATION		
• FIBER	CERAMIC FIBER FILTER METHOD	Crude fiber is loss on ignition of dried residue remaining after digestion of sample with 1.25% (w/v) H2SO4 and

		1.25% (w/v) NaOH solutions under specific conditions.
• OXALATES	TITRIMETRIC METHOD	The oxalic acid is extracted in HCl and precipitated as calcium oxalate by adding calcium chloride which is then washed and titrated with N/20 KMNO4 in the presence of dilute sulphuric acid at 70°C. one ml of N/20 KMNO4 is equivalent to 0.00225 g of oxalate
• PHYTATES	SPECTROPHOTOMETRIC METHOD	The phytic acid is extracted in 0.5 M nitric acid and treated with ferric ammonium sulphate and isoamyl alcohol. Pink color is dissolved in alcohol layer with ammonium thiocynate, which is invariably proportional to phytic acid content

PHASE V- Product Formulation:

In all three value added products shall be formulated incorporating dried green leafy powder. The names of products which shall be prepared are ladoo, sattu, panjiri and khakhara. All the recipes will be prepared by roasting method. Various studies have shown the better retention of nutrients in roasting.

The selected recipes will be standardized; thereafter the products shall be prepared by vegetable powders and one of the ingredients of standard recipes incorporating different proportions of dry leaf powder. One control recipe will be prepared containing no dry leaf powder and three variations of each recipe will be prepared containing varying percent (5%, 10% and 15%) of dry leaf powder.

PHASE VI- Organoleptic evaluation of recipes by using 5 point hedonic scale:

Organoleptic evaluation of all recipes containing different levels of dried leaf powder will be done on the basis of their color, taste, flavor/aroma, texture and overall acceptability on a 5 point hedonic scale from 5=very good, 4=good, 3=satisfactory, 2=poor, 1=very poor. At a time, one basic recipe (control or no leaf powder) will be cooked. Add the different levels of the dried powder in the different recipes.

PHASE VII - Nutritional composition of control and most accepted recipe will be evaluated in order to check the effect of method of cooking on nutrient retention of iron and beta carotene content.

PHASE VIII- The shelf life of the most accepted product will be analyzed by using standard techniques. Below mention table give details regarding the shelf life study of the most accepted product which will be conducted duration of every 15 days..

Shelf life study of the most accepted product:

CATEGORIES	PROCEDURE
1. SENSORY EVALUATION	5 POINT HEDONIC SCALE WILL BE USED AND PRODUCT WILL BE COMPARED WITH CONTROL RECIPE (RECIPE WILL BE PREPARED BY THE SAME DAY OF ESTIMATION)
2. MICROBIAL ANALYSIS	TOTAL VIABLE COUNT
3. RANCIDITY	PEROXIDE VALUE

PHASE IX- Cost analysis, nutritive value and Statistical analysis

The cost of the most accepted product/s shall be calculated by taking into account the average cost during the period of product formulation. The nutritive value of the most accepted recipe will be compared with the nutritive value of the control in order to determine % increase.

The data will be analyzed using statistical package. The significance difference between the nutrients and the method of drying will be studied by applying 'one way' ANOVA test and t-test for critical difference. The level of significance will be studied at 5%.

PHASE X- Report writing

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